FURTHER STUDIES OF TOOTH MORPHOLOGY

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RIDGES AND DEPRESSIONS ON TEETH

INTRODUCTORY REMARKS

Upon closer examination of larger series of specimens, the observer will find that aside from any of the features mentioned hitherto,[1] the crowns and cusps of human as well as some other mammal teeth, show various additional ridges and depressions.

These ridges and depressions in some teeth look rather insignificant, in others confusing. On the teeth anterior to the premolars, they are so often absent, inconspicuous or rudimentary, that they do not convey an impression of any morphological importance, while on the bicuspids and especially the molars there seem to exist such a variety and complexity of ridges that the mind does not readily connect the conditions and associate them with those on the rest of the teeth.

A closer study of these ridges and depressions soon shows, however, that they are not mere fortuitous formations, or developed perhaps just to increase the strength or grinding efficiency of the teeth—even though these may be their main functions; but that they follow, and that on all the teeth, a definite and unique pattern, which in the course of numerous comparisons becomes more and more apparent.

[1] "Shovel-Shaped Teeth." *Am. J. Phys. Anthrop.*, 1920, III, No. 4, 467-475.

This primary type or design is subject to various modifications, defects, distortions and connections, in both ridges and depressions, which even in human teeth alone make its study considerably involved; in many other mammals, the masticatory surfaces, particularly in the molars, have been functionally so altered that conditions such as seen in human teeth may seem wholly absent, or can be discerned only with considerable difficulty and uncertainty. Yet there are indications, particularly on the more anterior teeth, that the fundamental tendencies of ridging and grooving are inherently alike in all mammals.

In addition to the ridges and grooves just touched upon, some premolars and molars, particularly in certain species of the anthropoid apes, show more or less of unconformable "wrinkles," which plainly are of but little morphological importance and are not classifiable.

LITERATURE

A survey of the literature on tooth morphology shows that the ridges and depressions now under consideration have been noticed more or less by various authors, and have even been to some extent described in detail; but that, as in the case of the rim-and-fossa-formation, they have not as yet been studied sufficiently intensively and comprehensively. It is seen that as a result these formations are still known but imperfectly; that their significance has not as yet been clearly established; and that in some cases they have received a wrong interpretation.

The quoting of all the literature bearing upon these ridges and depressions would be difficult as well as confusing. The best notes on the subject are found in Black, an American author whose work seems to have remained unknown to the Europeans, and in Mühlreiter, a prominent German odontologist. Writing originally in the late eighties Black speaks thus of these formations: [1]

(P. 25). *Upper Median Incisors.—"Developmental Lines.* When any of the incisors first appear through the gums there are three little eminences or *tubercles,* called mammelons, on the cutting edge, with *grooves* crossing from labial to lingual side between them. These grooves run some distance on the labial surface, becoming broader and shallower till they disappear. In many, these lines appear on the

[1] BLACK, (G. V.), Descriptive Anatomy of the Human Teeth. 3rd. ed., Phila., 1894; also 2nd ed., 1891.

lingual surface between the marginal ridges and the fossa. Occasionally they are seen as far as the linguo-gingival ridge. . . These lines divide this part of the crown of the tooth into three *labial* lobes. Calcification begins in these mammelons as separate pieces, or plates, and the grooves are the marks of the after-confluence of these plates." . . .

(P. 29). *Upper Lateral Incisors.*—"The cutting edge, at the time of eruption presents three tubercles, or mammelons, and the grooves crossing the edge between these are projected on the labial surface as shallow labial grooves" . . .

(P. 34). *Canines (Upper); Labial Surface.*—"The greater convexity mesio-distally is caused by a strong labial ridge running from the point of the cusp to the gingival line. This ridge occupies so much of the surface of the tooth that its margins are imperfectly defined. It belongs to the middle lobe, developed from the middle plate which, in the incisors, is the smallest of the three, but in this tooth is much the largest. There are two labial furrows, or a flattening of the convexity between the central line of the ridge and each angle, marking the junction of the lobes. These furrows are usually lost by becoming shallower before reaching the centre of the length of the crown" . . .

(P. 37.) *Upper Canines, Lingual Surface.*—"Mesio-distally this surface is slightly convex in its central part on account of the lingual ridge which runs from the point of the cusp nearly, or quite, to the cingulum. On each side of this and between it and the marginal ridges, there is a slight but well-defined concavity and furrow, marking the confluence of the lobes. The marginal ridges arise from the mesio- and disto-incisal angles and unite with the linguo-gingival ridge or cingulum. These ridges are usually large near the angles, and much less pronounced toward the linguo-gingival ridge. The latter is prominent, and is often raised into a tubercle, or slight cusp. Occasionally this part of the enamel is thrown into irregular folds with grooves between, which are sometimes fissured. More rarely the small cusp may be divided by a groove" . . .

(P. 41). *Lower Canines, Lingual Surface.*—"The developmental lines, or grooves, are the same as those of the upper cuspids, but less prominent. Yet, generally, they can be seen in unworn teeth. Fissures are seldom seen in any part of this tooth." . .

(P. 42). "*The Bicuspids,* although unlike the incisors and cuspids in the contour of their crowns, have the same number and a similar

distribution of primary parts or *lobes*. They are, indeed, formed on the same general plan. The change of form is the result of a different relative development of the parts by which the cingulum, or linguo-gingival ridge, is elevated into a powerful *lingual cusp;* which, in the upper bicuspids, is almost or quite as high as the buccal cusp, but in the lower bicuspids, especially in the first, is less prominent. The middle lobe also forms a relatively larger part of the buccal portion of the crown than in the incisors and cuspids, while the mesial and distal lobes are relatively smaller. By the development of the lingual cusp of the upper bicuspids, the linguo-gingival grooves of the incisors and cuspids is carried to the central part of the crown, which it traverses from mesial to distal in a deep sulcus. It is naturally divided, by the mesial and distal pits found at its junction with the triangular grooves, into three parts; mesial, central and distal. In the lower bicuspids the lingual lobe is often very small and the course of the grooves irregular" . . .

(P. 45). *Upper 1st Bicuspid, Buccal Cusp.*—"The *buccal cusp* is the larger, and forms the terminal point of the buccal surface. From the point of this cusp, four ridges lead away at right angles. Two of these form cutting edges, which slope away mesially and distally to the mesio-bucco-occlusal and disto-bucco-occlusal angles, where they join the mesial and distal marginal ridges. The central buccal ridge leads away centrally on the buccal surface toward the gingival line, forming the convexity of this surface. The triangular ridge slopes down to the central part of the crown and joins a similar ridge from the lingual cusp to form the transverse ridge or ends in a central sulcate groove" . . .

Lingual Cusps.—"The lingual triangular ridge leads down from the central point of the cusp to the central groove, to join its fellows from the buccal cusp in the formation of the transverse ridge, or is divided from it by a deep central sulcate groove. This ridge is seldom prominent. Very frequently the central incline of the lingual cusp is a plain surface.

"The *mesial* and the *distal* marginal ridges are strong ridges of enamel which rise in the mesial and distal terminations of the cutting edges of the buccal cusp, and form the mesial and distal margins of the occlusal surface. They join with the ridge forming the lingual cusp; or they are usually divided from the latter by the mesial and

distal grooves; though these grooves are often indistinct, especially in teeth that have been somewhat worn.

"The occlusal surface of the bicuspids have five *developmental grooves;* the central, mesial, distal, mesial triangular and distal triangular. The central groove is deeply sulcate, and divides the triangular ridges, or passes over their junction as a shallow line, and sinks into a triangular pit at either end. The mesial and distal grooves are really continuations of the central, which pass over the marginal ridges as very fine lines or as more definite grooves, and mark the boundary of the lingual lobe. They are rarely fissured while the central groove is frequently fissured throughout its course. The triangular grooves, mesial and distal, run from the mesial and distal pits toward the mesio-buccal and disto-buccal angles, dividing the marginal ridges from the triangular. They are occasionally sulcate in the first part of their course and are generally lost toward the mesio- and disto- buccal angles by becoming shallower, but in young unworn teeth they can often be followed as a fine line running over the cutting edges of the buccal cusp near the angles, and leading into the buccal grooves. These are the marks of confluence of the mesial and distal lobes with the middle lobe. In the central incline of the lingual cusp, supplemental grooves are often seen meeting the triangular grooves of the buccal side. The triangular grooves are occasionally fissured for a short distance from their junction with the central." . . .

(P. 50). *Upper 2nd Bicuspid.*—"The general form of the *occlusal surface* is similar to the first bicuspid. It presents a buccal and lingual cusp, and similar sulcus, ridges, grooves and pits. The average height of the cusps is considerably less than in the first bicuspid. The marginal ridges are proportionately broader, the mesial and distal pits closer to each other and the central groove shorter. The triangular grooves join the central groove nearer the mesio-distal center of the tooth, making the buccal triangular ridge narrower and more nearly pointed. In many examples the enamel of the occlusal surface is thrown into several shallow wrinkles, or supplemental grooves and ridges, which radiate from the central groove, which occurs but rarely in the first bicuspid." . . .

(P. 53). *Lower First Bicuspid.*—"The buccal cusp presents the same ridges leading from its summit as described for the upper first bicuspid, but the pair which form the cutting edges usually form a

curve with its convexity to the buccal, and merge into the marginal ridges by more rounded angles. The buccal triangular ridge is narrow and prominent and joins the elevated lingual ridge or cusp forming a complete transverse ridge. In many instances this is deflected to the mesial or distal. In young teeth, the central groove often crosses the transverse ridge as a fine line, which soon disappears by wear. However, in many examples the transverse ridge is divided by a deeply sulcate groove. There is a deep pit at the mesial and the distal ends of the central groove, or on either side of the transverse ridge from which the triangular grooves, which divide the marginal ridges from the triangular, or transverse ridge, run toward the mesio- and disto-buccal angles. These are often sulcate in the first part of their course. In many young teeth these grooves may be traced over the cutting edges on to the buccal surface, marking the confluence of the central with the mesial and distal buccal lobes." . . .

(P. 55). *Lower Second Bicuspid.*—"The lower second bicuspid is a little longer than the lower first, and of much the same figure, except that the lingual cusp is proportionately higher and more nearly, but never quite, on a level with the buccal, but the lingual surface is about equal to the buccal in mesio-distal breadth. These teeth are regular in general contour, but the grooves of the occlusal surface are much diversified. These differences may be classified under three forms: 1st, The central groove joins the triangular grooves in such a way as to form a half circle with the convexity to the lingual, with or without a transverse ridge crossing its line. In these, when the transverse ridge is high, only a deep pit appears on either side. 2nd. The lingual cusp is divided by a sulcate groove, which runs over centrally, or nearly so, to the lingual surface, making a three-cusped tooth. The central groove forms an angle at the junction with the lingual, or is crescentic in form. It joins with the triangular grooves in such a way that the point of junction cannot be told except by finding the mesial and distal grooves, which are often very indistinct. 3rd. The central groove is straight and generally sulcate with a deep pit at each end. In many examples, these pits are crossed by the triangular grooves almost at right angles with the central. By tracing the fine mesial and distal grooves carefully in young unworn teeth, it will be found that the lingual lobe is much larger than in the lower first bicuspid, and almost as large as in the upper bicuspids. In the

three-cusped forms the two lingual lobes are usually a little broader from mesial to distal than the buccal portion of the tooth."

Black makes also an effort to describe the ridges on the molars, but fails to recognize their identity and describes them as if they belonged to the whole tooth rather than to individual cusps. He calls the median ridge of each cusp the "triangular ridge." His illustrations also fail to convey the standard pattern.

The next, in time, American name of prominence in research on teeth is that of Wortman. This author has published a number of valuable contributions to Odontology both human and comparative, and he has noted some of the ridges and depressions on the teeth, but like others, has never given these features a special attention. In his "Comparative Anatomy of the Teeth of the Vertebrata" (American System of Dentistry, 1886) we find the following remarks bearing on the points under consideration:

There is nothing about the ridges and furrows in incisors:

(P. 441). *Canines.*—"In the superior canines a slight ridge descends upon the external or labial face from the summit of the terminal cusp to the neck, but is absent in the corresponding teeth below" . . .

"The palatine convexity is occasioned by a well-marked vertical ridge which extends from the summit of the terminal cusp to the cingulum below; this latter structure is usually well defined, being stronger in the upper than in the lower teeth" . . .

(Pp. 442-443). *Inferior Premolars.*—"Two strong cusps of which one is external and the other internal, occupy the grinding face, and are separated by a deep notch or valley, deepest in the centre. The anterior and posterior margins of this valley are bordered by slight ridges which connect the anterior and posterior extremities of the cusps; the anterior of these is a little more elevated than the posterior and forms a useful guide in determining the mesial and distal surfaces of the tooth, and consequently the side of the jaw to which it belongs. In some instances the enamel forming the floor of the valley and adjacent sides of the cusps and ridges is quite smooth, but most frequently it is considerably wrinkled and thrown into a number of minor cusps and ridges, with intermediate indentations which offer receptacles for the lodgment of food" . . .

"The internal vertical ridge of the external cusp, joins this cingulum near its central portion, leaving a deep pit upon either side,

where the destructive agencies of decay on the crowns of these teeth exhibit themselves most frequently. The degree to which this vertical ridge is developed is subjected to great variation; it may be almost entirely absent in some individuals or strongly developed in others. The crown of the second or posterior bicuspid or premolar is more quadrate in outline than the anterior or first; the internal cusp is better developed, and frequently shows a tendency to form two."

Other American and English investigators on teeth, such as Cope, Tomes, Osborne, Scott, Gidley, Gregory, Woodward and others have in general paid attention only to the crowns and cusps as a whole, to the sulci separating the different cusps, and to the secondary ridges connecting some of the cusps, in the human and primate teeth. They have studied the teeth from a different standpoint, with attention concentrated on the gross forms, and on the origin, identities and homologies of the various cusps, rather than on the finer modelling, which in relation to these larger problems must have appeared of very subsidiary importance.

Among authors of other countries, the first place in this connection belongs to those publishing in German, and the foremost in this line are Mühlreiter, Zuckerkandl, Rose, Kükenthal, and more recently Schlosser, Walkhoff, Adloff, de Terra, Bolk and Stehlin. With these investigators too, attention so far has been concentrated essentially on the larger features of the teeth; notwithstanding which however the finer features received also more or less consideration. This especially by Mühlreiter and Zuckerkandl.

Zuckerkandl, in his classic *"Anatomie der Mundhöhle mit besonderer Berücksichtigung der Zähne"* (8°, Vienna, 1891), has the following to say about the ridges and depressions observable on the human teeth:

(P. 34). *Upper Median Incisors. Labial Surface.* "In strongly developed teeth the labial surface shows two shallow furrows which begin at about the middle of the crown and extend longitudinally to the cutting edge of the tooth" . . .[1]

[1](P. 34). *Upper Median Incisors. Labial Surface.* "Bei kräftig gebildeten Zähnen ziehen an der Lippenfläche zwei seichte Längsfurchen bis an die Schneide hinab, die in halber Kronenhöhe beginnen. Sie theilen die Schneide in drei Zacken, welche bald nach dem Durchbruche der Zähne durch Abnutzung verloren gehen." . . . .

(P. 35). *Upper Median Incisors. Lingual Surface.* "a.) Die linguale Zahnfläche ist, vom schmalen Saume abgesehen, blos ganz leicht vertieft, und an

(P. 35). *Upper Median Incisors. Lingual Surface.*—On this surface "(a) are found three grooves, two of which begin immediately below the tubercle. These grooves end on the cutting edge, and give rise to the formation of several longitudinal ridges.

"(b) There proceed from the tubercle one to two ridges which gradually become flatter until they disappear on the lingual surface."

"(e) The tubercle is prolonged, at the same time becoming gradually less prominent, up to the cutting edge of the tooth. Between this prolonged ridge and the elevated lateral borders on each side is formed a small depression."

(P. 39) *Lower Median Incisors.*—"The upper half of the labial surface on freshly erupted teeth, shows two longitudinal grooves which end in depressions in the cutting edge giving rise to three small cusps."

(P. 42).[1] *Upper Canines.*—"Laterally near the border on each side there is found in most cases a small furrow-like depression or groove by which the median enamel ridge which runs from the neck to the point of the tooth is even more accentuated."

(P. 45).[2] *Upper Premolars.*—"The masticatory surface of the buccal cusp is strongly convex and branching from the transverse furrow shows not seldom two short lateral depressions, through which the surface of the cusp is subdivided into several ridges. The middle of these is usually the stoutest. The corresponding surface of the lin-

derselben finden sich drei Furchen, von welchen zwei unmittelbar unterhalb des Tuberculum beginnen (Fig. 8D). Die Furchen endigen oberhalb der Schneide und geben Veranlassung zur Bildung von mehreren Längswülsten.

(b.) "Vom Tuberculum gehen ein bis zwei Wülste aus, die allmälig sich verflachend an der Zungenfläche verschwinden (Fig. 8B)." . . .

(e.) "Das Tuberculum verlängert sich, dabei allmälig flacher werdend, bis gegen die Schneide hin. Zwischen dem verlängerten Wulste und dem aufgeworfenen seitlichen Rande etablirt sich je ein Grübchen." . . . .

(P. 39). *Lower Median Incisors.* "Die Lippenfläche ist wenig gewölbt und an eben durchgebrochenen Exemplaren (in der oberen Zahnhälfte) mit zwei Längenfurchen versehen, die an der Schneide Einkerbungen erzeugen und zur Bildung von drei Zacken Veranlassung geben." . . . .

[1](P. 42). *Upper Canines.* "Seitliche nahe den Rändern finden sich zumeist kleine furchenförmige Vertiefungen oder Grübchen (siehe Fig. 13B) durch welche die mittlere Schmelzleiste, welche vom Hals gegen die Spitze herab verläuft, noch um so stärker herausgearbeitet erscheint." . . . .

[2](P. 45). *Upper Premolars.* "Die Kaufläche des buccalen Höckers ist stark gewölbt und zeigt nicht selten zwei seitlich gestellte, aus der Querfurche abzweigende kurze Rinnen, durch welche die genannte Höckerfläche in mehrere Nebenwülste zerlegt wird. Der mittlere von diesen ist dann gewöhnlich der breiteste. Die Kaufläche des lingualen Höckers ist gleichfalls stark gewölbt und secondare Furchen an derselben werden auch hin und wieder beobachtet." . . . .

gual cusp too, is strongly convex, and here and there will also show secondary furrows."

(P. 49).[1] *Lower Premolars.*—"The two cusps are connected by a narrow enamel ridge . . . The Masticatory surfaces of the cusps show on each side between the median ridge and the elevated lateral border, a rounded depression."

In dealing with the molars, Zuckerkandl devotes his attention to the number of cusps and to the main furrows. His only remark concerning the ridging of the cusps is as follows:

(P. 60).[2] *Molars.*—The masticatory surfaces of the cusps are convex, and frequently such a surface, or even all of them, is subdivided by secondary grooves into small ridges.

Mühlreiter, while in the main following Zuckerkandl, goes considerably further in certain particulars, and presents on the whole the best non-English contribution to our knowledge of the more detailed tooth modeling. In the third edition of his *"Anatomie des menschlichen Gebisses"* (Leipzig, 1912; also second edition, 1891), we read as follows:[3]

(P. 18). *Upper Median Incisors.*—"Only a few upper median incisors have a completely smooth labial surface. In the majority of cases there may be noted on these surfaces a slight longitudinal marking or folding. This consists usually of three, sometimes barely traceable, sometimes well pronounced, but always only slightly elevated longitudinal ridges, between which exist two shallow main grooves, which begin about the middle of the crown, run to the cutting edge and divide the latter in unworn teeth into three rounded little cusps."

[1](P. 49). *Lower Premolars.* "Die Spitzen der beiden Höcker sind durch eine schmale Schmeltzleiste untereinander verbunden. . . . Man findet demnach an der Kaufläche, zu beiden Seiten der Mittelleiste und randständig von den Seitenwülsten begrenzt, rundliche Grübchen."

[2](P. 60). *Molars.* "Die Kauflächen der Höcker fallen von den Zackenspitzen mit gewölbten Flächen gegen die Kreuzfurche ab und häufig sind einzelne der genannten Flächen, seltener sogar alle, durch Nebenfurchen in kleinere Wülste getheilt."

[3](P. 18). "Wenige obere Zentralschneidezähne haben eine vollkommen glatte Lippenfläche. Bei der Mehrzahl gewahrt man an der letzteren eine zarte Längenstreifung oder Faltung, welche ihrem Grundzüge nach gewöhnlich aus drei bald nur angedeuteten, bald deutlich ausgeprägten, aber immer nur schwach erhabenen Längenleisten besteht, zwischen welchen zwei seichte Hauptfurchen, ungefähr in der halben Kronenhöhe beginnend, bis zur Schneide herablaufen und letztere bei intakten Kronen in drei abgerundete Zacken teilen." . . . .

(P. 20). *Upper Median Incisors. Lingual Surface.*—"More frequently [than a complete lack of modeling] there are met with three (exceptionally also two or four) more or less shallow grooves, running parallel and without break, hence similarly as on the labial surface, from the tubercle to the vicinity of the cutting edge; and these grooves are accompanied and respectively bounded by two weakly pronounced median and the two marginal ridges.

Still more frequently however,[1]) the two median ridges which immediately after their origin from the tubercle are somewhat more prominent and more sharply defined, will diminish and after a short course, run to a point, while the remaining concave part of the lingual surface up to the cutting edge retains the ordinary faint grooving. The tubercle appears thereby in its distal part provided with two short independent folds or ribs."

Curiously enough, the artist who drew the eight teeth in Mühlreiter's Fig. 4, represented in four of these a triple, instead of a double lingual ridge, which seems to have escaped the author's attention.

(P. 37). *The Canines.*—The labial surface shows a dull vertical ridge . . .

(P. 38). The lingual surface is divided into two by a prominent median ridge which reaches from the tubercle to the point of the tooth. "Between this median ridge and the usually equally well developed marginal ridges, there is found on each side a furrow-like depression" . . .

Speaking of some aberrant forms, Mühlreiter says:

(P. 39). "Especially characteristic of this form of the crown is the

(P. 20). *Upper Median Incisors. Lingual Surface.* "Häufiger ist jedenfalls die unter A (Fig. 4) abgebildete Form anzutreffen. Es ziehen parallel zueinander drei (ausnahmsweise auch zwei oder vier) mehr oder minder seichte Furchen ohne Unterbrechung, also ähnlich wie an der Lippenfläche, vom Tuberkulum ausgehend bis in die Nähe der Schneide und werden begleitet resp. begrenzt von zwei schwach ausgeprägten Mittelleisten und den beiden Randleisten.

(P. 37). *The Canines.* "An der Lippenfläche ist insbesondere die Querwölbung in der Halsgegend viel bedeutender, als bei den Schneidezähnen; in der unteren Hälfte dieser Fläche wird indessen die starke Rundung dadurch unterbrochen, dass von der Mittelspitze eine stumpfe Längenleiste abgeht, die, nach oben schwächer werdend, sich alsbald gänzlich verliert, diese untere Partie der labialen Fläche aber in zwei mehr minder plane Facetten teilt.

(P. 38). Die Zungenfläche "wird durch eine, jedoch kräftig hervorgewölbte, von dem Tuberkulum bis zur Spitze reichende, in gleicher Richtung gar nicht oder nur schwach konkave Längenleiste in zwei Hälften geteilt. Zwischen der Mittelleiste und den gewöhnlich ebenfalls gut entwickelten Randleisten befindet sich je eine furchenförmige Vertiefung, die bei einigermassen vorgeschrittener Abnutzung in ein seichtes, ovales Grübchen umgewandelt wird." . . . .

almost constant occurence besides the median ridge of a second, even though shorter longitudinal elevation, on the part of the surface between the median ridge and the border of the tooth, and separated from the median ridge as well as from the terminal part of the marginal ridge by a more or less deep depression." [1]

(P. 48). *Upper Premolars.* The masticatory surface of the buccal cusp is frequently provided, especially near the point, with a prominent median ridge. A similar ridge, but generally less marked, is seen in corresponding location on the lingual cusp. Besides this, as "Zuckerkandl very properly remarks, not seldom there appear on both sides of the masticatory surface also several secondary ridges, separated from the stouter median ridge by small secondary grooves radiating from the main furrow between the two cusps. This is an expression of the same folding which appears with such a predilection on the lingual surface of the upper front teeth, and which shows the masticatory surface of the buccal cusp of the upper pre-molars to be topographically identical with the lingual surface of the incisors and canines.

"In individual cases the folding extends also to the lingual cusp, and the whole masticatory surface of the teeth appears then ridged, with grooves radiating between the ridges." [2]

[1](P. 39). "Besonders kennzeichnend für diese Kronenform ist das fast konstante Auftreten einer zweiten, wenn auch kürzeren Längenleiste neben der mittleren, welche den zwischen der letzteren und der distalen Ecke gelegenen Teil der Zungenfläche okkupiert und sowohl von der Mittelleiste wie vom Ende des Randwulstes durch eine mehr minder tiefe Einkerbung getrennt wird." . . .

(P. 48). *Upper Premolars.* "Kaufläche. Die beiden Höcker sind verhältnismässig kräftig und ziemlich gleichmässig entwickelt, die schärfere Spitze des bukkalen Höckers überragt nur wenig jene des lingualen. Die stark gewölbte und steil abfallende Rückwand des ersteren—die Wangenzone der Kaufläche—ist häufig, besonders an der Spitze, mit einer prominierenden Mittelleiste versehen, die an der entsprechenden Fläche des Zungenhöckers gewöhnlich etwas schwächer markiert ist. Sehr richtig bemerkt Prof. Zuckerkandl, dass nicht selten an beiden Zonen der Kaufläche mehrere Nebenwülste auftreten, welche durch sekundäre, aus der Hauptfurche abweigende Rinnchen von der breiteren Mittelleiste getrennt werden. Es spricht sich hierin dieselbe Faltenbildung aus, welche an der Zungenfläche der oberen Frontzähne so gern vorzukommen pflegt und durch welche die Kauflächenzone der oberen Prämolarhöcker sich als topographisch identisch mit der Zungenfläche der Schneide und Eckzähne erweist.

[2]An einzelnen Examplaren erstreckt sich ferner die Faltung auch auf die Seitenwülste, und es erscheint dann die Kaufläche von einem Kranze von Fältchen eingesäumt, deren Zwischenfurchen strahlenförmig auslaufen." . . . .

(P. 58). *Lower Premolars.*—"Similarly as in the upper bicuspids, the masticatory surface of the buccal cusp of the lower bicuspids shows also, as a rule, a prominent and steep median ridge, accompanied fairly frequently on the distal part of the surface, but only very seldom on the mesial part, by a secondary ridge."

(P. 69). "In the folding of the masticatory surface of each cusp of the molars is found an expression of the same architectonic type we have seen on the cusps of the premolars and which in general is proper to every cusp occurring on the human teeth. A strongly prominent, fairly broad and very often bevelled median ridge proceeds steeply from the point of the cusp to its base, and is separated by secondary grooves from the small lateral ridges which run into the borders of the cusp and represent so to say the marginal ridges proper to each cusp. It is self understood that there are many variations in the degree of development of these various features and that these can only be studied on intact, unworn teeth."

Regrettably there are no illustrations of this pattern, and the author attempts no deductions as to its significance.

Wortman, in his "Comparative Anatomy of the Teeth of the Vertebrata" (*Am. System of Dentistry*, 1886), has nothing to say about ridges and furrows on the incisors. As to other teeth, there are the following notes:

(P. 441). *Canines.*—"In the superior canines a slight ridge descends upon the external or labial face from the summit of the terminal cusp to the neck, but is absent in the corresponding teeth below."

"The palatine convexity is occasioned by a well-marked vertical ridge which extends from the summit of the terminal cusp to the

(P. 58). *Lower Premolars.* "Ganz ähnlich wie bei den oberen Backenzähnen besitzt auch die Kauflächenzone des Wangenhöckers in der Regel eine stark prominierende und steil abfallende Mittelleiste, zu welcher sich ziemlich häufig an dem distalen Abschnitte, aber nur höchst selten an dem mesialen eine Nebenleiste gesellt. . . . .

(P. 69). *Upper Molars.* "An der Kauflächenzone eines jeden einzelnen Höckers spricht sich in der Faltenbildung dasselbe architektonische Gepräge aus, das wir an den Höckern der Prämolaren bereits kennen gelernt haben und das überhaupt jedem an den menschlichen Zähnen auftretenden Kronenhügel zu eigen ist. Eine stark prominierende, verhältnismässig breite und sehr oft gratartig zugeschärfte Mittelleiste zieht in steilem Abfalle von der Spitze bis zum Fusse des Höckers und wird jederseits durch ein sekundäres Rinnchen von den beiden zarten Nebenfältchen getrennt, welche in die Hügelränder auslaufen und sozusagen die proprietären Randleisten des einzelnen Höckers repräsentieren. Selbstverständlich machen sich in dem Grade der Ausbildung dieser Einzelnheiten mannigfache Schwankungen geltend und können dieselben überhaupt nur an intakten, nicht abgenützten Zähnen studiert werden." No good illustration of this pattern. No deductions.

cingulum below; this latter structure is usually well defined, being stronger in the upper than in the lower teeth" . . .

(Pp. 442-443). *Inferior Premolars.* "Two strong cusps of which one is external and the other internal, occupy the grinding face, and are separated by a deep notch or valley, deepest in the centre. The anterior and posterior margins of this valley are bordered by slight ridges which connect the anterior and posterior extremities of the cusps; the anterior of these is a little more elevated than the posterior and forms a useful guide in determining the mesial and distal surfaces of the tooth, and consequently the side of the jaw to which it belongs. In some instances the enamel forming the floor of the valley and adjacent sides of the cusps and ridges is quite smooth, but most frequently it is considerably wrinkled and thrown into a number of minor cusps and ridges, with intermediate indentations which offer receptacles for the lodgement of food." . . .

"The internal vertical ridge of the external cusp, joins this cingulum near its central portion, leaving a deep pit upon either side, where the destructive agencies of decay on the crowns of these teeth exhibit themselves most frequently. The degree to which this vertical rib is developed is subjected to great variation; it may be almost entirely absent in some individuals or strongly developed in others. The crown of the second or posterior bicuspid or premolar is more quadrate in outline than the anterior or first; the internal cusp is better developed, and frequently shows a tendency to form two."

Molars. Nothing about cusp ridges—author barely touches upon "corrugation."

Tomes, in his "Manual of Dental Anatomy" (6th ed., London, 1904), has even less to say about the ridging and grooving of teeth than Wortman. His principal remarks in this connection are:

(P. 579-580). *Canines.* "The crown terminates in a blunt point, which lies in a straight line with the long axis of the root; a feebly pronounced line or ridge runs down the outer surface of the tooth from this point to the neck . . . The internal or lingual surface is not concave like that of the incisors, but is in a slight degree convex, and a median ridge runs down it from the apex of the cusp; this ridge where it meets with the ridge which borders the lingual surface and corresponds with the cingulum of the incisor teeth, is often developed into a well-marked prominence or slight cusp" . . .

On the lower canines "the perpendicular labial ridge is not trace-

able, and the want of symmetry between the mesial and distal halves of the crown less marked." . . .

(P. 581). *Premolars, Upper.* "It is, however, not uncommon, especially in the lower races of mankind, to see some indication of a median ridge upon the labial surface, defined by slight grooves upon either side" . .

But little besides the above:

(P. 584). "A longitudinal section through the crowns of the two teeth will demonstrate without the necessity of further description that the basal cusp of the canine and the inner cusp of the bicuspid are the same thing, differing only in degree, while it is interesting to note that the pulp chamber in the bicuspid has hardly any prolongation towards the small inner cusp, so that the resemblance between the two teeth is thus made more complete" . . .

"The transition from the bicuspids to the molars is more abrupt; at least it is not so easy to point out exactly how the cusp pattern of the one would arrive at the form of the other. But it merely needs an exaggeration of the differences existing between a canine and a first bicuspid to make a good imitation of a second bicuspid.

"If any one will take the trouble to make mental note of the deviations in form which he meets with even in human teeth, he will find that they almost invariably consist of approaches towards the form of the teeth on either side of them; and will infallibly be led to the conclusion that incisors, canines and bicuspids are not three patterns of teeth perfectly distinct, and each *sui generis*, but that they are modifications of one and the same pattern."

Tomes has nothing to say about the ridges on the cusps of the molars, mentioning only the connecting ridge between the *ai* and the *pe* cusps of the upper molars.

In 1898, Selenka, in his "Menschenaffen,"[1] calls attention to the occurrence of various wrinkles or ridges on the lingual surface of the incisors of the orang[2] but without distinguishing any special constit-

[1]SELENKA (E.), Rassen, Schädel und Bezahnung des Orangutan; 6 Heft, Wiesbaden, 1898, p. 57, figs. 82, 83.

[2]"Sämtliche Zähne des Orangutan, sowohl der ersten wie zweiten Dentition, tragen ein ganz eigenartiges Gepräge, welches sie von den Zähnen der übrigen Affen unterscheidet; man kann sie daher, solange sie nicht stark abgekaut sind, fast ausnahmslos als Orangutanzähne erkennen. Dieses spezifische Merkmal besteht vor allem in den zahlreichen Schmelzrunzeln, welche bei Schneide—und Eckzähnen auf der lingualen (Innen-) Fläche, bei allen Backzähnen auf der

uent. His illustrations however, show plainly the existence of a double (main) central vertical ridge on both the temporary and the permanent median upper incisors which he pictures, and of one marked median vertical ridge on each of the two lower medians (1 temporary and 1 permanent) and the three laterals (lower temporary, upper and lower permanent) which are included in his plate. In addition all these teeth show more or less redundance of the enamel borders of the lingual surface and a corresponding approach to the shovel-shaped conformation.

A year later, in describing the teeth of the gorilla and chimpanzee,[1] Selenka reports a wrinkling of the lingual surface of the incisors in both of these forms, also, but here again goes into no details or analysis of the various ridges.[2] The illustrations show a single stout median ridge on each of the temporary upper median incisors of a young chimpanzee (p. 111, fig. 14, C); a single median ridge on each of the permanent upper incisors, and an even better developed such ridge on each of the lower incisors as well as the canines, in an adult female chimpanzee (p. 112, fig. 117); a single median ridge on the two upper median and on all the lower incisors of a juvenile orang,

Kaufläche liegen . . . Bisweilen traten Längsriefen auch auf der labialen (äusseren) Fläche der Schneidezähne, seltener der Eckzähne auf. Regelmässig zieht eine tiefe Längsfurche auf der vorderen Seite des oberen, und auf der hinteren Seite des unteren Eckzahns der ganzen Krone entlang."

[1]Ibid. Heft 7, 1899.

[2]"Sämtliche Zähne des Orangutan sowohl der ersten wie der zweiten Dentiton, tragen einen eigenartigen Stempel, welcher sie von den Zähnen ihrer Verwandten unterscheidet: Schneide—und Eckzähne zeigen auf der Innen—oder Lingualfläche deutliche Längsrunzeln, die Kaufläche der Backzähne und der oberen inneren Schneidezähne zalreiche feine unregelmässige Runzeln. Im intakten Zustande kann daher bei einiger Übung jeder Orangutan-Zahn als solcher erkannt werden, ausgenommen etwa die unteren äusseren Incisivi des Milchgebisses, deren Runzeln bisweilen nur schwach hervortreten (vergl. Seite 60-61), sodass sie den gleichnamigen Zähnen des Schimpanse gleichen können.

Milch- und Dauerzähne des Schimpanse ähneln überhaupt denen des Orangutan; denn auch bei jenen sind die Innenflächen der Schneide—und Eckzähne mit Längsrunzeln, die Kronflächen der Backzähne mit unregelmässigen Runzeln besetzt; aber diese Runzeln sind stets spärlicher und schwächer ausgeprägt als auf den Zähnen des Orangutan. Die Milchschneidezähne des Schimpanse erscheinen nämlich auf der Lingualfläche meistens nur schwach gerieft . . . Die Dauerzähne sind immer gefurcht und gerunzelt, am stärksten die Molaren. . . . Auf der Innen- und stets deutlich auf der Aussenfläche der Milchschneidezähne verlaufen beim Gorilla sehr schwache Furchen oder Riefen; Runzeln fehlen ihnen jedoch . . . Die Dauerzähne des Gorilla (Seite 75, Seite 135 bis 144) zeigen folgendes. Die Incisivi sind auf der Lingualfläche mehr oder weniger stark mit Längsfurchen versehen, die Canini mit wenigen tief einschneidenden Riefen."

with approach of all eight teeth to shovel-shaped formation (p. 120, figs. 120, 121); a single median ridge on all the upper as well as lower incisors in an adult female chimpanzee (p. 122); an approach to shovel-shaped conformation in all the incisors of an "ideal denture" of the adult gibbon, with traces of two median ridges on each of the upper median teeth (p. 123, figs. 134, 135); faint single to double median ridges on all the incisors in an "ideal denture" of an adult gorilla (p. 124); and prominent single broad median ridge on the right upper median, a double ridge on the left upper median, with single ridges on the rest of the incisors, upper and lower, in an "ideal denture" of an adult orang constructed on the basis of a photograph from several specimens (p. 125).

In 1902, in the same serial (H. 9, p. 296, fig. 50), Otto Walkhoff illustrates the fragmentary Krapina upper jaw, in which the three remaining incisors, besides being shovel-shaped, show each a strong lingual multiapical cusp, while the canine bears a complete vertical median ridge with an oblong depression on each side.

In 1908 the subject of ridging and grooving on teeth is touched upon in several places by Adloff in his "Das Gebiss des Menschen und der Anthropomorphen" (8°, Berlin). His remarks are to the following effect:

(P. 11). *Upper Median Incisors.*[1] "The labial surface shows two shallow longitudinal depressions, which in newly erupted teeth end in two notches in the cutting edge of the teeth." On the lingual surface "there are usually three slight longitudinal furrows which, beginning at the tubercle, proceed to the cutting edge of the tooth."

(P. 12). *Canines.* "On the labial surface a distinct ridge runs from the neck of the tooth to the point, and along this ridge on each side is a shallow depression. On the lingual surface, similarly, a prominent ridge extends from the more or less developed tubercle to

[1](P. 11). "Die labiale Fläche . . . zeigt zwei seichte Längsvertiefungen, die bei eben durchgebrochenen Zähnen in zwei Einkerbungen der Schneide einmünden." . . . *Lingual Surface.* "Am Tuberculum beginnend, ziehen gewöhnlich drei leichte Längsfurchen zur Schneide des Zahnes" . . . .

(P. 12). *Canines.* "Die labiale Fläche ist gewölbt. Vom Zahnhalse zur Spitze verläuft deutlich eine etwas erhöhte Leiste; ihr entlang zu beiden Seiten verlaufen zwei flache längliche Vertiefungen. Ebenso zeigt die linguale Fläche keine Konkavität wie bei den Schneidezähnen, sondern eine Wölbung. Auch hier zieht von dem mehr minder entwickelten Tuberculum eine kräftig hervortretende Leiste zur Spitze. Zu beiden Seiten derselben ist je eine ihr parallele seichte Vertiefung bemerkbar." . . . .

the point of the tooth, while on each side of the same is observed a parallel shallow depression."

(P. 13).[1] *Upper Anterior Premolars.* On the labial cusp " a broad ridge that extends from the neck of the tooth to the point of the cusp, is found with a shallow groove on each side of it, so that the cusp is plainly divided into three parts. This division of the labial surface in the anterior premolar is almost always distinctly recognizable, but has mostly completely disappeared in the posterior premolar" . . .

As to the masticatory surfaces of both the anterior and posterior premolars, the author occupies himself mainly with the depressions that can here be observed. And in the case of molars he says nothing about the detailed ridging of the cusps, paying attention essentially to the cones and furrows.

A few other notes concerning the ridging of teeth are found in Paul de Terra's volume on the "Vergleichende Anatomie des menschlichen Gebisses und der Zähne der Vertebraten" (8°, Jena, 1911).

(P. 363). "The *incisors,* after eruption, are trilobate, with longitudinal grooves which correspond to the three lobes and which may be traced up to the middle of the crown." The points of these lobes become gradually worn off, until the cutting edge is even. "The lingual surface is concave and marked by longitudinal furrows" . . .

(P. 364). The labial surface of the *upper median incisors* "is slightly convex and shows two shallow longitudinal furrows."

[1](P. 13). *Upper Premolars.* "Die oberen Prämolaren besitzen zwei Höcker, einen labialen und einen lingualen. Der labiale ist der höhere und breitere. Vom Zahnhalse verläft auf der labialen Fläche eine breite Leiste zur Höckerspitze, zu ihren beiden Seiten zwei flache Furchen, so dass der Wangenhöcker deutlich dreigeteilt ist. Diese Dreiteilung der labialen Fläche ist beim ersten Backzahn fast immer deutlich erkennbar, beim zweiten ist sie meistens gänzlich geschwunden" . . .

"Die Kaufläche des zweiten Prämolaren zeigt ein klein wenig anderes Bild. Von ihrer Mitte aus verlaufen nach den vorderen und hinteren Ecken divergierend je zwei Furchen, die ihrerseits am vorderen und hinteren Zahnrande sich wieder vereinigen, so die Form einer Acht bildend. Dabei können aber die beiden flachen Vertiefungen, die sich auf die labiale Fläche fortsetzen, gleichfalls vorhanden sein. Bisweilen verläuft aber nur zwischen den Höckern eine kleine Längsfurche während Querfurchen vollständig fehlen;" . . .

(P. 363). "Die Schneidezähne . . . nach dem Durchbruch, sind dreilappig, mit Längsfalten, welche den drei Lobi entsprechen and welche sich bis auf die halbe Länge der Krone verfolgen lassen. Diese Lobi nützen sich allmählich derart ab, dass schliesslich die Schneidefläche ganz eben erscheint . . . Die linguale Fläche ist konkav und mit Längsrinnen versehen." . . .

(P. 364). *Upper Median Incisors.* "Die Labialfläche ist leicht konvex und zeigt zwei seichte Längsfurchen."

(P. 369). *Upper Canines*: "The dull median ridge divides the labial surface into two triangular facets" . . .

Lingual Surface: "The median ridge, which is also present here, forms together with the well-developed marginal ridges the boundaries of the triangular depressions, which through wear become gradually shallowed until they wholly disappear."

There is nothing on the upper premolars or molars, and for the rest of the teeth de Terra follows Zuckerkandl.

Still another author of prominence who has recently dealt in part with the ridging and grooving of human teeth, is L. Bolk, of Amsterdam. In his elaborate and involved "Morphogenie der Primatenzähne" (8°, Jena, 1914), he touches repeatedly on the subject of the detailed modelling of the crowns and cusps, both in text and in illustrations, but the separate ridges and grooves are not taken up specifically, and nothing is added to our previous knowledge concerning them. The author, in common with a large majority of odontologists, has concentrated his attention on the cusps and crowns as such and on the subdividing fissures, rather than on the seemingly secondary ridges and depressions.

Among the most recent American authors, Osborn and Scott have for the time being evidently ceased detailed work in odontology; Gregory's excellent work is as yet unfinished; while Wortman, Gidley and Hellman are now devoting their attention to collateral subjects of importance.

NEW OBSERVATIONS

The writer's observations on the finer modeling of teeth followed naturally and almost inevitably upon the studies of "shovel-shaped" incisors. [1]

It was seen that in numerous cases, and that both in man and lower mammals, the lingual surface of the incisors, whether shovel-shaped or not, was marked and at times radically modified by a vertical median ridge. Occasionally the human median upper incisors

(P. 369). *Upper Canines.* "Durch die stumpfe Längsleiste wird die Labiale Fläche in zwei dreiseitige Felder geteilt, ein mesiales schmäleres und ein distales breiteres." . . .

Lingual Surface. "Die auch hier vorhandene Mitelleiste begrenzt zusammen mit den gut entwickelten Randleisten zwei flache dreiseitige Gruben, welche durch die Abnutzung sich allmählich verflachen, um schliesslich ganz zu verschwinden" . . .

[1]Vol. III., No. 4, *Am. J. Phys. Anthropology.*

showed two and even more smaller ridges on the lingual surface; and some more or less plain ridging and grooving was also observed in cases on the labial surface of the teeth. These ridges, both lingual and labial, were soon noticed to be quite independent of both the keilo- and koilomorphy (rim and fossa formation) of the teeth; though the lingual fossa when it existed was now and then observed to be affected by the median ridge, which obscured it more or less and at times, when strongly developed, converted it into two inconspicuous lateral depressions.

It was next observed that these conditions were in substance very much like those occurring on the more posterior teeth, the canines, premolars, and even the molars. In human teeth, lingually or on the masticatory surfaces of the cusps, the same fundamental pattern seemed to appear everywhere where the parts were better developed. This led ultimately to a detailed study of the conditions; and to avoid all extraneous influence literature was not consulted until after the completion of the studies.

The observations were carried out in the main on the extensive human as well as comparative osteological material in the U. S. National Museum. They were very much interfered with by the exceedingly common partial to complete wear of the enamel and consequent obliteration of the finer modeling; but there were also found numerous specimens that gave valuable evidence or indications. The best series of teeth was obtained by carefully breaking up fragments of jaws of Indian children of which a large number was on hand for just some such need. They gave perfect teeth in all stages of immature condition, which alone made it possible in a number of important respects to arrive at some definite conclusions.

The results of the observations are briefly given below. The whole study has convinced the author that there exists a fundamental homogeneity in tooth formation, modified only by functional adaptations, and by degree and perfection of the development of the crowns and individual cusps. Furthermore, these studies do not bear out any of the hitherto advanced theories of tooth morphogeny,[1] but point in another and that quite distinct direction.

The ridges and depressions on the crowns and also on the cusps

[1]Enumerated in H. F. Osborn's admirable "Evolution of Mammalian Molar Teeth," 8°, N. Y., 1907; in L. Bolk's "Morphogenie der Primatenzähne," 8°, Jena, 1914; and in Gregory's most recent publications in Odontology.

of the teeth are fixed, not incidental characteristics. They vary in detail, but recur typically and in the same locations. They are fundamentally alike in the teeth of man, in those of primates and in those of lower mammals. And they appear not only on the incisors, but also on the canines, premolars and molars.

After sufficiently extensive and repeated observations it is seen that, in fact, there is one and the same inherent ridge type for all the teeth from the incisors to the molars, and in all the mammals; but that this type is not developed with equal precision in the different teeth or the different species. The several ridges constituting the type do not have equal potentiality. Some are what might be termed generally prepotent, and therefore in general better developed and more common; while others of weaker potentiality are frequently absent, or deformed, or reduced to mere fragments or vestiges, particularly in certain teeth and certain species. The "potency" of the ridges appears generally to be proportionate to the functional importance of the parts of the teeth to which they appertain.

This ridged condition of the crowns and cusps is so generalized that it compels the assumption of its constituting another of the fundamental characters of the teeth. The ridges according to all indications are homologous formations wherever they occur. They are liable to more irregularity as we proceed from the canines backward. On the molars and particularly the wisdom teeth they are liable to much distortion and rudimentation. In other mammalian forms they may be so distorted or modified as to be wholly unrecognizable. They may be accompanied and quite obscured by accessory wrinkles of the enamel. Yet every now and then in widely different species their presence becomes plainly manifest, or at least may be discerned.

All the above speaks for the morphological importance of these formations. Moreover there is evidence that they or some of them are intimately connected with keilodonty or the rim and fossa formation; and that they have a considerable phylogenetic significance.

DESCRIPTIVE NOTES

The ridges and their corresponding depressions are divisible into those of the labial and those of the lingual or masticatory surface of the teeth.

The *labial* ridges with parallel depressions or grooves may best

be studied on the upper median incisors, but occasionally and in a more or less imperfect form become manifest also on other incisors, on the canines and on the premolars. To the trained eye and under a good magnifying glass traces of them will be visible on many teeth where they otherwise might pass unnoticed; but they are usually absent, or present only in vestiges, on the molars.

The *lingual* (or masticatory) ridges and depressions, are on the whole more conspicuous than the labial, except in some incisors. They may be plainly seen on a large proportion of the canines; they may generally be discerned on the buccal cusp of the premolars, and occasionally, in traces, also on the lingual cusp of these teeth; and they are seen on the human and most closely related teeth on the principal, and in rare instances even on the secondary, cusps of the molars.

THE LABIAL RIDGES

PLATE I

The labial ridges and depressions are more simple and uniform than the lingual, though they are not without variation. In their typical form on a median upper incisor the total labial surface of the crown will be seen to be marked by three well defined, rather broad, longitudinal elevations, one central and two marginal, with two intervening grooves or depressions. In unworn teeth the ridges are seen to reach the edge of the tooth and end there in three tubercles, while the grooves end in the depressions between these tubercles, the whole giving a serrated type to the edge of the tooth. In especially marked cases the central and lateral welts will be such as to divide the crown into three nearly equal parallel or somewhat diverging columns or lobes—this especially in the median incisors. In the lateral incisors the central lobe is liable to be the stoutest and its terminal point to project beyond that of the lateral lobes, particularly that on the distal edge of the tooth. In some primate incisors, and especially in the incisors of the carnivora, we find that the three "lobes" in question correspond to three more or less distinct cones, and it thus becomes plain that the three labial ridges which we observe occasionally in man, some anthropoid apes and some other mammals, correspond to the cone areas of the triconodont type or phase of the tooth, while the two depressions between the ridges are homologous with the cone separations. The gap between a typical triconodont and a typical

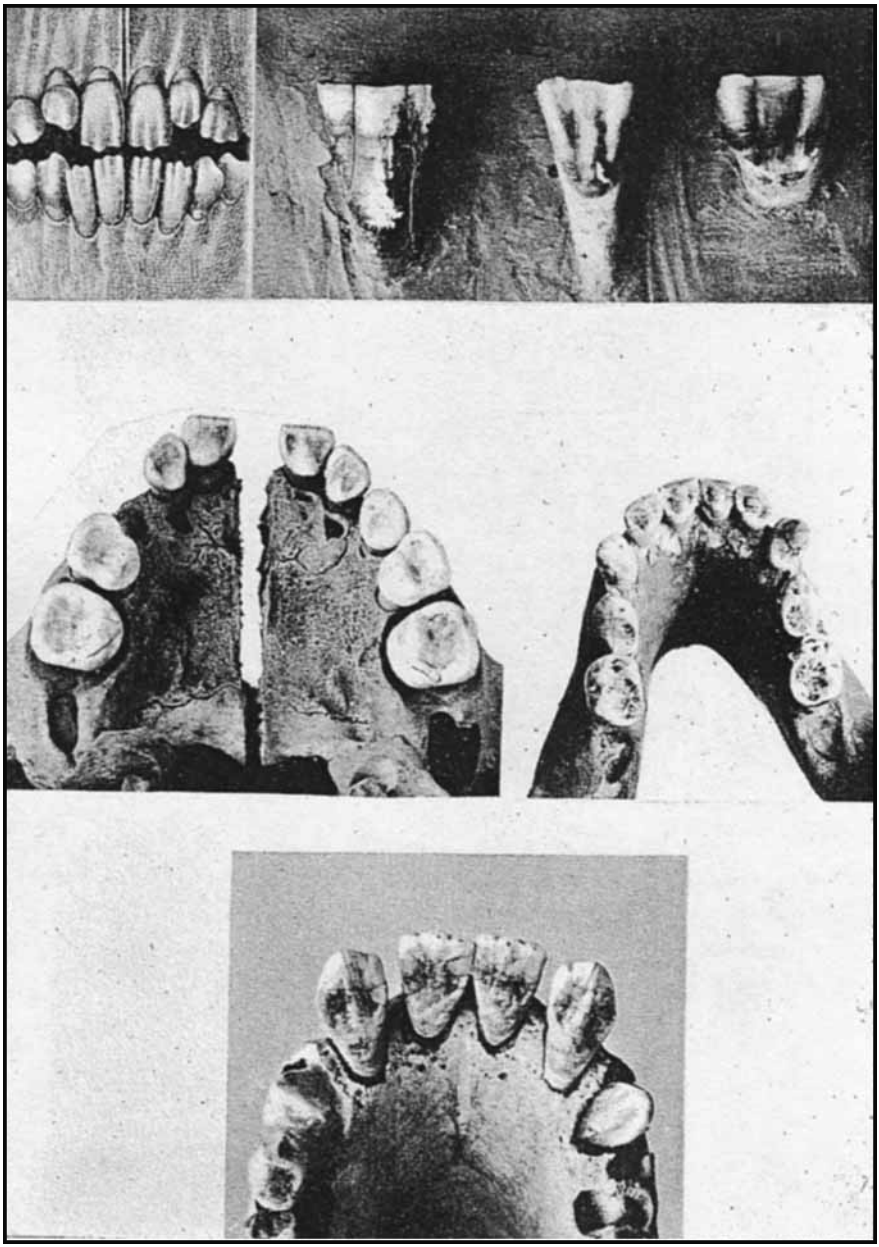


PLATE I. UPPER LEFT FIGURE: Permanent front teeth of a German boy; showing labial ridging. (After Zuckerkandl). —UPPER RIGHT: Permanent upper median incisor of (a) an Orang (142,196, U. S. N. M.); (b) a Water Buffalo of Celebes (219,763, U. S. N. M.) and (c) American Indian (loose teeth, U. S. N. M.), showing identical type of labial ridging. —MIDDLE LEFT: Skull of a Sioux child (243,362, U. S. N. M.) with a complete single median ridge on each of the deciduous median upper incisors. A partial median ridge on left lateral incisor. —MIDDLE RIGHT: Orang (144,691, U. S. N. M.), showing deciduous lower incisors with a well developed rim, lingual concavity and pronounced median ridge. —LOWER: Orang (153,821, U. S. N. M.), with permanent lower teeth showing a tricuspid edge (median and partly also lateral incisors, and a marked single median ridge (lateral incisors and canines).

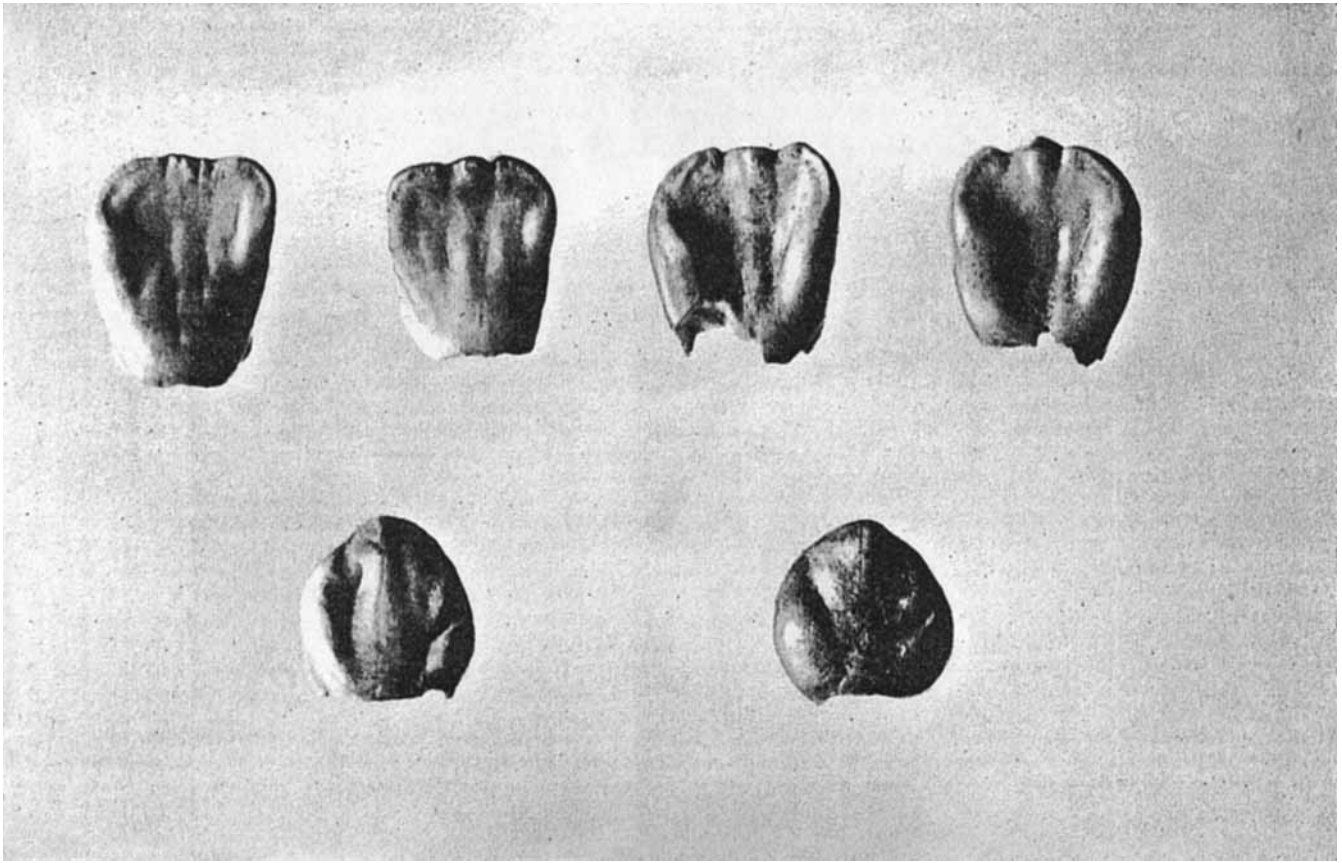


PLATE II. UPPER ROW: Immature Median Incisors, the two on left Old Egyptian (XII Dyn.); on right, Indian.
LOWER ROW: Immature Indian Canines.
Nos. 1 and 2 above show three lingual ridges each besides the two marginal ones; the third shows two ridges (besides the marginal), the right and median, while the fourth shows the left and the median lingual ridge. The canines below show each the two marginal ridges, a pronounced median ridge and fragments of the lateral ridges, particularly the left.

labially tri-lobed incisor with a sufficient number of specimens at our command could probably be filled without interruption, and the correspondences here mentioned be actually demonstrated. As we pass to the more posterior teeth however, the matter becomes progressively more difficult.

The variations in man of the tri-ridge and bi-groove pattern of the labial surface of the incisor, and occasionally of the canine and even a premolar, consist most frequently in diminished clearness of these structures; in a preponderate rôle assumed by either the median or the lateral ridges, in the first instance the surface appearing but single ridged, while in the other much rarer cases and limited to incisors, the labial surface of the tooth with the lateral welts well developed and the median inconspicuous to absent, comes to resemble considerably the rim-and-fossa condition of the lingual surface; and it in fact is more than a resemblance.

The indications of the features under consideration on the canines and even on the premolars and molars, however rare and imperfect they may be, can signify of course but one fact—a fundamental identity of organization or histogeny of these teeth with that of the incisors.

LINGUAL RIDGES

PLATES I, II, III, IV

The occurrence of enamel ridges on the lingual surface of the teeth is more frequent and in general much more conspicuous than that of those on the labial surface. Moreover they are found on all the teeth, though on the molars they are practically restricted to the cusps and are "masticatory" rather than "lingual."

The fundamental lingual ridge pattern of the human teeth is that of a median, two lateral and two marginal ridges—hence five ridges in all with three intervening depressions. The median ridge is straight and vertical; the laterals may be straight or slightly curved, and proceed distad in a more or less divergent way from the median ridge; the two marginal (or rim) ridges are as a rule somewhat curved, and follow the margin of the teeth. It is the two lateral inside ridges which are the least stable and regular, while the median and the marginal ridges appear to possess about the same potentiality. Of the lateral ridges one or the other may be completely absent, with the other slightly to well developed, in which case the result will be two

lingual ridges, such as are seen occasionally on the upper median incisors. These particular ridges may be of a double, coronal and accessory, origin. They develop with the crown, and can be found before the cingulum joins the latter; but they may subsequently be strengthened or even represented by an extension of two points from the cingulum or tuberosity. When both the lateral ridges are absent, we obtain the single median ridge type which is the most common of all the variations of the ridging. When the marginal as well as the lateral ridges are wanting and the median exists, we have a form such as seen frequently in the canines. When the lateral as well as the median ridges are absent and the marginal exist, we have the keilokoilodont or shovel-shaped form, which is so frequent in certain human and ape upper incisors. Finally, when all the lingual ridges are absent we obtain the smooth surface such as is found in many incisors of the modern white man.

The manifestation of these lingual ridges differs in its tendencies in the different teeth.

The median ridge occurs occasionally on the median upper incisor; more frequently on the lateral upper incisors; in some instances on the lower incisors (both deciduous and permanent); generally on the canines; as a rule on the outer cusp of the bicuspids; with varying frequency, according to the individual teeth, on the inner cusp of these teeth; and almost invariably on the three older cusps of the molars, but occasionally also appearing on the fourth and fifth cusps. No cusp whatever is devoid of the possibility of developing the median ridge, but as a rule only the larger better developed cusps will show the feature. Not infrequently the median ridge is obscured in the median convexity of a cusp or a tooth. Where better discernible it generally extends from the base to the point of the crown or cusp of the tooth. And it may be so developed as to take up a larger part of the inner or lingual surface of the cusp or tooth. It can be plainly traced in the teeth, even in the canines, of the anthropoid and other apes, and in many of the teeth of the lower mammals. It is the central ridge of the median main "lobe" of the tooth, or the "protoconid," and of the corresponding portion of each cusp.

This ridge possesses a considerable significance. Its homology on the various teeth and on the cusps in the molars cannot be questioned. Its function on all is evidently to strengthen the tooth or cusp, and it corresponds to the median external ridge. a well defined presence of

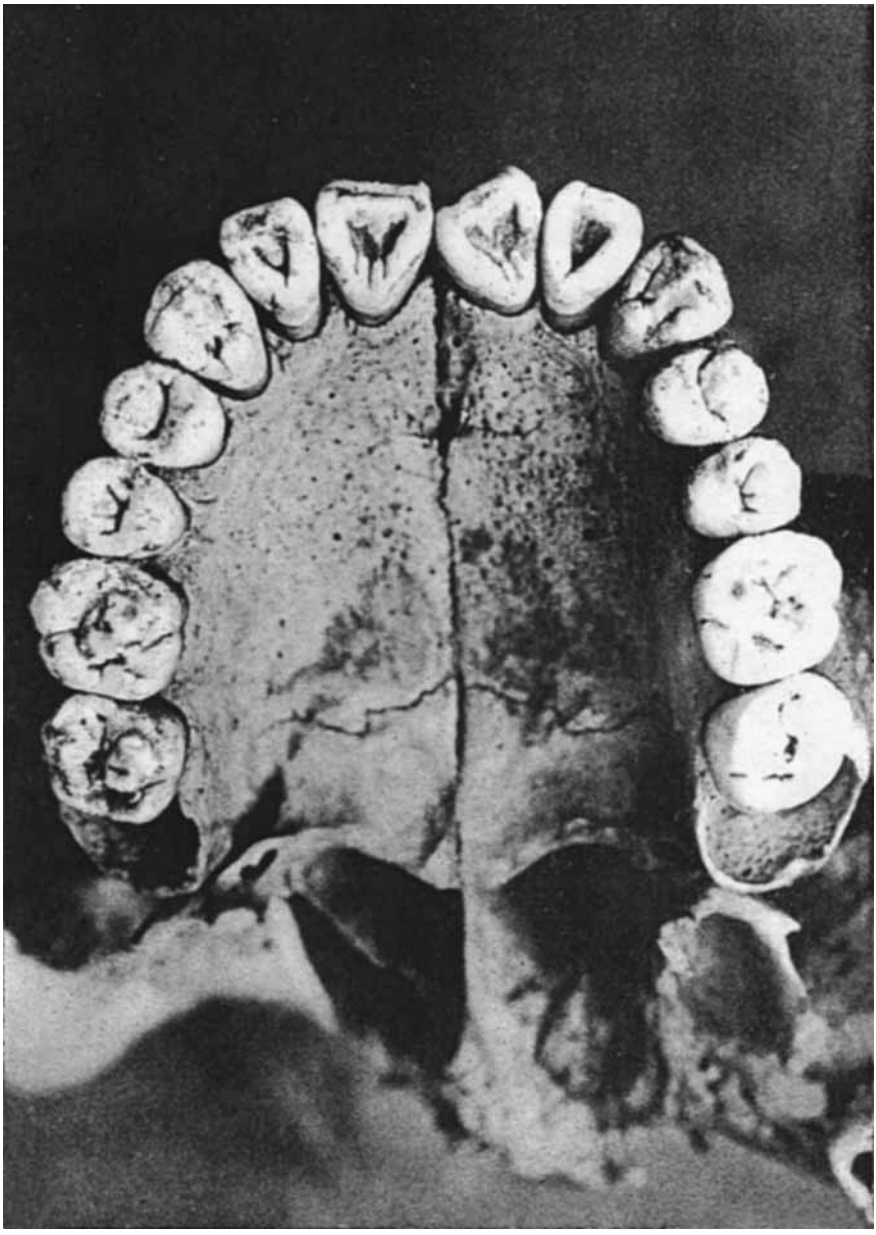


PLATE III. Skull of a prehistoric or early historic Peruvian Indian (293,114, U. S. N. M.); median shovel-shaped incisors show each 2 heel cuspules; right lateral, a partial median ridge; both laterals a marked complete rim and pronounced fossa; both canines a distinct rim, a median ridge and heel cusp.

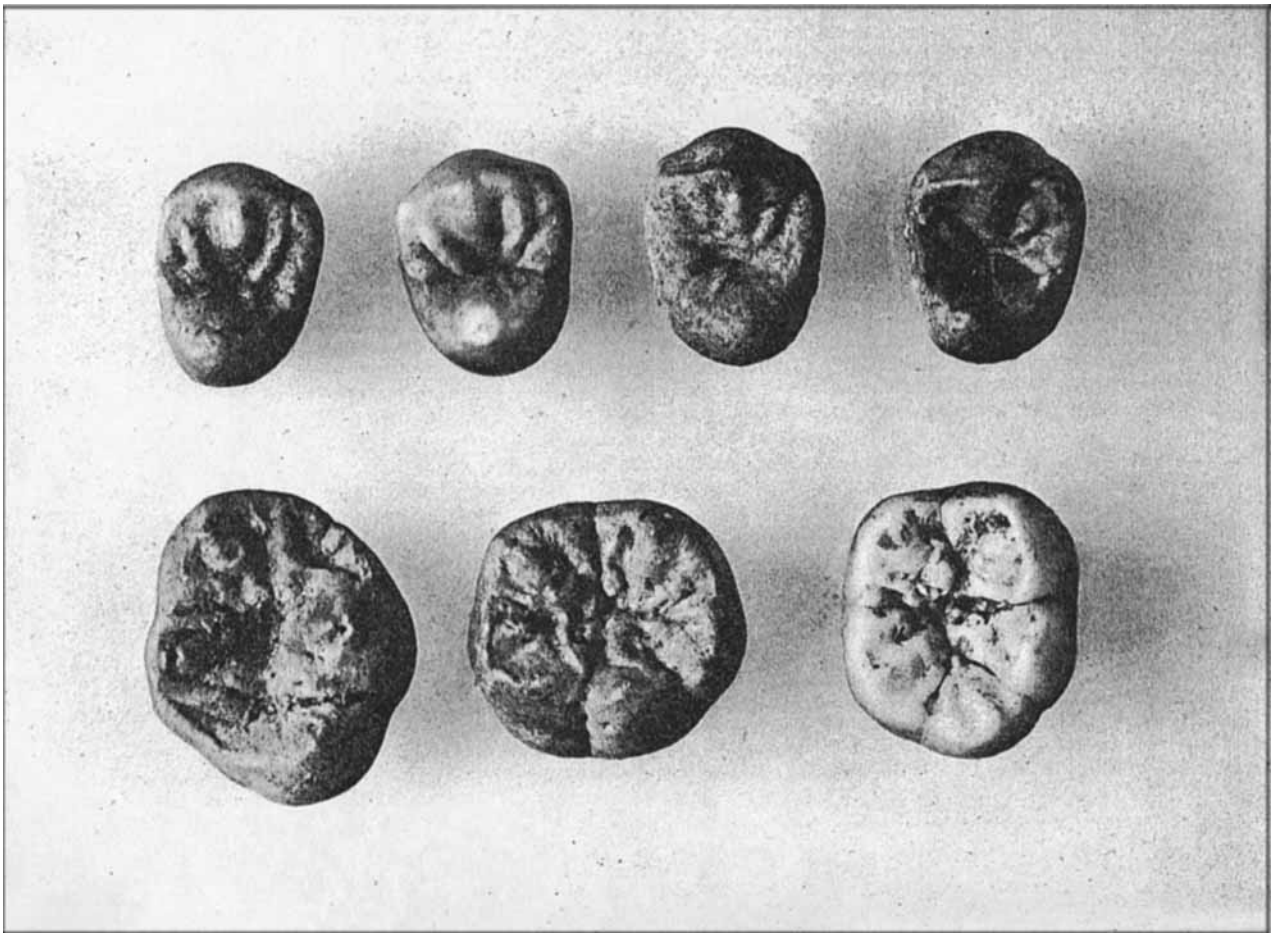


PLATE IV. Immature Indian Upper Premolars and Molars, showing ridging. Two of the premolars show clearly the five ridges, the median, two laterals and two marginals. On the molars the cusps show the median and marginal ridges. (Enlarged)

which however is less frequent. Its presence on the cusps of the molars, even occasionally on the latest additions, the fourth and fifth cusps, is a remarkable condition. These cusps are not "lobed;" they are not "triconodont;" for if they were each cusp of the molars would have the value and significance of an individual, primitive, ancestral tooth. But the presence of the median ridge, homologous with that of the premolars, canines and incisors, suggests that the cusps of the molars are following in the line of standard development of all the teeth; and that if conceivably their evolution could progress in the same direction, each cusp would develop the tri-lobed or triconodont character of each of their more anterior separate teeth. If this can be substantiated it must naturally have a far reaching influence upon our whole view of tooth development and evolution. The real ancestral feature would then be, not the Cope-Osborn triconodont tooth, but a general inherent tendency towards a triconodont formation.

The lateral or intermediary lingual ridges, are the median strengthening ridges of the lateral "lobes" of the teeth. They are best developed, on the whole, on the outer cusps of the upper premolars. Occasionally they may be clearly represented also on the median incisors. They are occasionally perceptible in a fragmentary form on the canines; and traces of them seem to be distinguishable occasionally on a cusp of a molar, but their identity here is as yet uncertain. In conformity with the lesser development of most of the lateral lobes and cones, these ridges are also less conspicuous and are frequently reduced to mere vestiges or are absent altogether. Their morphological significance goes only so far that they show over the lateral ridges or cones of the teeth the same mechanism as exists for the strengthening of the important central lobe. Nothing exactly corresponding to these ridges is observable on the labial or dorsal surface of the teeth, though the lateral ridges occasionally seen there bear some relation.

What in the above respects applies to man may be said also of the chimpanzee, gorilla and orang, though the conditions show more or less aberrance. This is particularly true of the canines of these species, yet the median lingual ridge, once well known, can readily be distinguished even on these far specialized "brutalized" teeth. In the lower incisors of these apes the median ridge assumes much more importance than it does in these teeth in man, in whom in fact it is here rarely noticeable. Furthermore the marked development of the

median ridge in the anthropoid lower incisors extends to both the deciduous as well as the permanent set.

In the lower apes, excepting a few of the largest forms, conditions in these respects are considerably simplified and it is impossible to distinguish clearly more than the single median ridge, which however exists on most of the teeth and cusps.

In the Carnivora the single median lingual ridge is noticeable to pronounced on the incisors and pre-canines, may be traced on the canines, and is again discernible to well marked on the premolars and molars. In the Ungulates the single median ridge is slightly to exceedingly well marked on the lower incisors (the only incisors present), and may be traced on the lingual aspect of the premolars and molars. It assumes great strength and prominence on the lower incisors of some of the Suidae. The median ridge may also be perceived on some of the teeth of the rodents and marsupials. It is its presence which justifies the viewing of all mammalian teeth as essentially lophodont and lophoconid.

What is the significance of all these ridges? It will be impossible to say a final word on this point without further comprehensive studies including those of an embryological and palaeontological character. Nevertheless the examination of such extensive material as that at the disposal of the author permits of some tentative conclusions.

These are briefly as follows:

(1) The crowns and cusps of the human and other mammalian teeth show in general an inherent tendency to ridging, or to *lophodonty* and *lophoconidy*.

(2) The functional role of the ridging is to strengthen the teeth and cusps and to assist trituration of food.

(3) There is but one fundamental pattern of ridging of both the crowns and the cusps in the whole mammalian kingdom; which pattern however is subject to a wide range of modifications.

(4) The ridging is partly marginal (keilodonty) but in the main intermarginal (lophodonty, lophoconidy); and the latter is directly connected with an equally inherent and old triconodont tendency of the teeth and cusps.

(5) The intermarginal ridges are the axial ridges of the more or less differentiated "lobes" or "cones" of a tooth, the lobes or cones

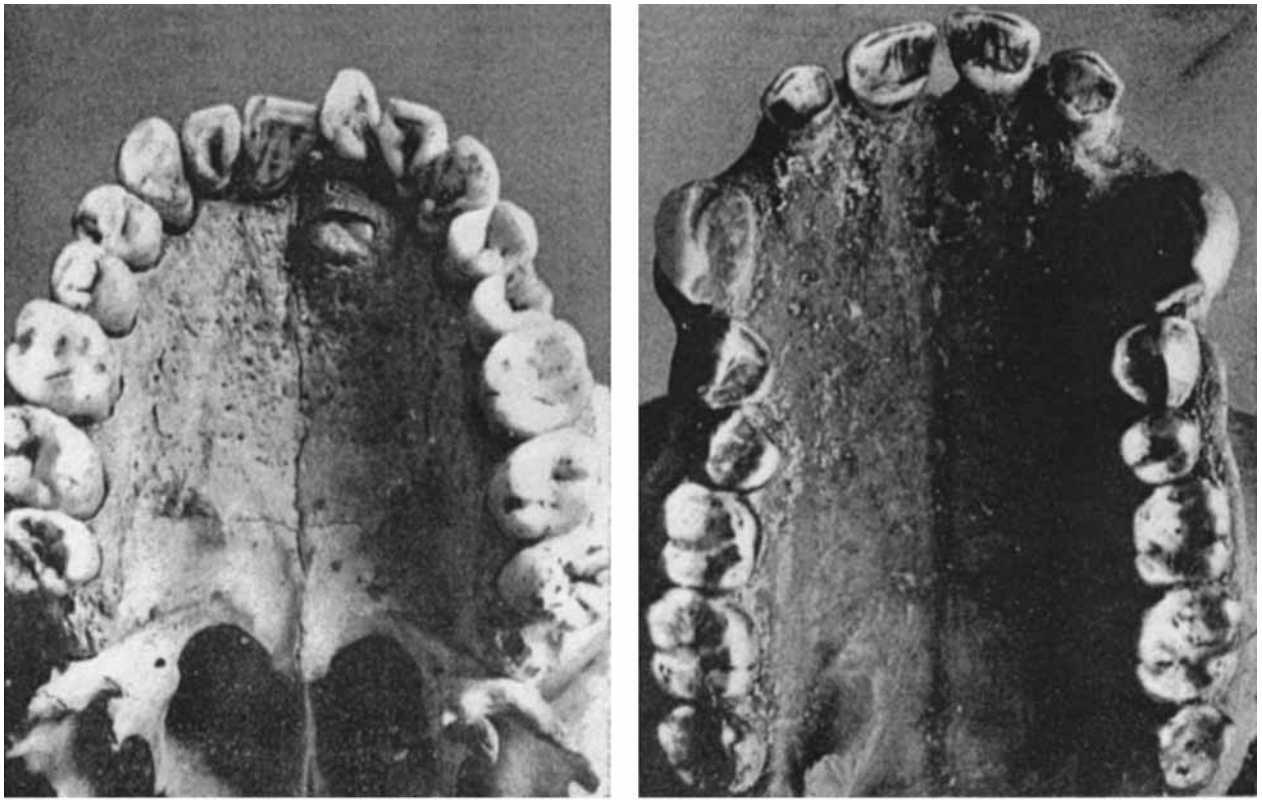
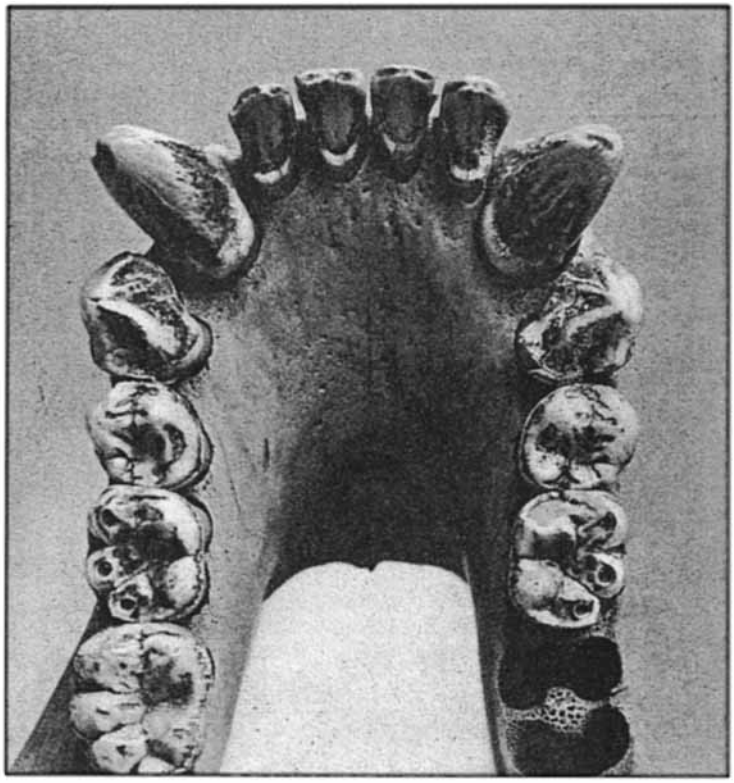


PLATE V. TRICUSPID PREMOLARS

LEFT. Bannock Indian, Male, (243,837, U. S. N. M.). Left anterior upper premolar clearly tricuspid.
RIGHT. Hylobates sp., Sumatra, Male (123,151, U. S. N. M.); left posterior upper premoral clearly tricuspid. (Actual size of parts seen, Fig. 1, length, 7.3 cm.; Fig. 2, 4.3 cm.)



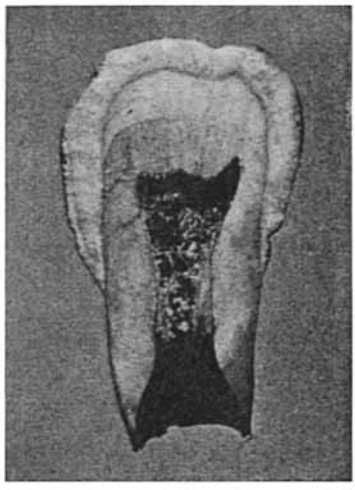


PLATE VI. UPPER: Mandible of a Male Gorilla (176,211, U. S. N. M.), showing molariform posterior premolars. The right premolar shows three distinct small accessory cusps which if enlarged would reproduce the three posterior cusps of the first molar. (Natural size).

LOWER: Lingual, right lateral and mid-section views of an immature Indian upper median incisor (Div of Phys. Anthrop., U. S. N. M.), showing a peculiar. nearly circular, developmental fissure in the enamel at about the upper boundary of the cingulum, with traces of another fissure below. The section shows faintly a small accessory root projecting downward from the dentine. (Actual length of tooth=13 mm.)

that in extreme cases would give the typical triconodont tooth, or a triconed cusp.

(6) The differences of the ridging in the crowns of the incisors or canines and the cusps of the premolars or molars, are merely those of degree.

(7) The median of the intermarginal ridges of a crown or a cusp is without exception the best developed and most frequent. It is the axial ridge of the "protocone" or "main lobe," and the main strengthening ridge of the crown or a cusp as a whole.

(8) The depressions lateral to the intermarginal ridges are remnants of keilomorphous feature of the surface, a separate condition.

(9) Phylogenetically, lophodonty and lophoconidy do not appear to be either remnants of or reversions to any primitive ancestral condition of teeth or cusps, but an inherent morphological tendency of progressive possibilities.

(10) Finally, the results of the study of these ridges together with that of the cingulum and the cusps, indicate the entire homology of the various teeth; the homomorphy of the crowns and the cusps; and the origin of the various teeth not by differentiation of a primitive triconodont type (Cope, Osborn), or by accretion of primitive teeth (Kükenthal, Röse, etc.), or from an original bicuspid, or "dimere" form (Eterode, Bolk), but from monomere crowns with the cingulum, by the development, under functional call, from the cingulum, of additional cusps, with similar morphogenic endowments or possibilities as those of the older crown or cusp, and which gradually assume a stabilization and similar form with the older constituents of the tooth.

THE CINGULUM. THE CROWN "SUTURE"

PLATES V, VI

The cingulum has long been a sort of a "will-o'-the-wisp" of dental anatomy. Everyone speaks of it, and many have more or less casually attempted to define it,[1] but no one has as yet dared to tell us conclusively just what it is, what are its boundaries, the reasons for its being, and its potentialities.

To the zoologists and the paleontologists, the cingulum is of even greater concern than to the student of human teeth. They understand by it the enamel swelling or belt that surrounds or embraces

[1]See first section of this communication, *A. J. P. A.*, 1920, III., 429 et seq.

the crown of the tooth near its base, and from which at times are seen arising accessory cusps of the teeth; but they, in common with human anatomists, do not clearly distinguish between features that may and may not be attributed to cingulum origin.

In his study of immature human teeth, the writer observed a number of conditions which have more or less bearing on these points. And in the first place it was seen how easily it would be possible for one to be misled by appearances assisted as they may be by the views of respected authors.[1] A number of the Indian incisors and other teeth under examination showed on the developing crown a peculiar cross "suture" of which no mention could be found in the available dental literature, and which gave the impression as if it might possibly mark the junction line of the cingulum with the rest of the crown. In one case especially, that of an upper permanent median incisor (Plate VI) it seemed as if we had a plain separation of the cingulum. But further studies weakened whatever confidence there may have been placed at first in these manifestations, and finally took away all hope that anything like a separate development of the cingulum could be established.

What was observed on the dry material (mostly of prehistoric Indian origin), was briefly as follows:

[1]A separate development of this basal portion of the enamel was believed in specially by Black (Descriptive Anatomy of the Human Teeth, Black (G. V.), Phila., 1st ed., abt. 1889; quoted after 4th ed., 1897; same in 3rd ed., 1894). He calls it the linguo-gingival ridge, and his views on the part are as follows:

"The lingual surface of the crown [of the upper incisors] (Fig. 2), is concave in all directions forming a *fossa,* bounded by the cutting edge, the mesial and distal marginal ridges, and the linguo-gingival ridge or cingulum. . . The *linguo-gingival ridge* is a strong elevation of the enamel forming the linguo-gingival border of the crown. It is sometimes elevated into a tubercle . . . The calcification of the linguo-gingival ridge or cingulum, is also begun as a separate plate, forming the *lingual lobe,* but afterwards it becomes united to the other parts by confluence, leaving a groove, often very slight indeed, and soon obliterated by wear, marking the line of union. This is the *linguo-gingival groove.* (This groove is properly three grooves corresponding with the mesial, central and distal grooves of the bicuspids, while the linguo-gingival ridge corresponds to the lingual cusp). In smooth regularly formed teeth it begins at the gingival line just lingual of the summit of its labio-lingual curvature, and runs across the marginal ridge at right angles with its length, then runs almost horizontally across the lingual surface to the distal marginal ridge. This ridge is now crossed at right angles, and the gingival line reached. The length of the groove usually includes from a quarter to a third of the circumference of the tooth. When the linguo-gingival ridge is prominent or rises in the form of a tubercle, this groove is subject to much variation in its course. Occasionally, especially in the lateral incisors, a sulcus, or a fissure divides the linguo-gingival ridge from one of the marginal ridges, and extends into the cementum. This is the linguo-gingival fissure."

Crown Development. The Cingulum. The crowns as a rule were seen to commence to develop with what was or were to be their most distal points, and what were probably the oldest points phylogenetically. At various times during earlier childhood it is possible to find in the alveoli the tips of the cusps of the molars, premolars and canines, the cutting edge portion in the incisors. The enamel development appears to dominate over that of the dentine which on the inside forms its thin and morphologically probably passive lining.

As the growth proceeds, the crown and cusps manifest gradually all the main features which they are to bear in the fully developed teeth. Thus there appear—in teeth where they are to exist—from an early stage the marginal, median, secondary and labial ridges with their corresponding concavities. All this well before the appearance of "cingulum" or the root.

Next, in the molars, the cusps coalesce and the growth of the crown proceeds uniformly until the enamel reaches its basal limits, but before it has reached these and before the dentine lining begins to protrude to form the roots, the enamel already shows a perceptible basal swelling—the cingulum. Microscopically there has been no separate brace, no accessory enamel body. The cingulum formation appears to be inherent in and constitute an inseparable part of process of the development of the enamel portion of the crown of each molar.

The premolars follow practically the same course of development as the molars. The tip of the labial cusp appears first, then that of the lingual; the two then join, and the enamel grows uniformly in the direction of the eventual root. The basal swelling of the enamel, or cingulum, appears in the last stages of the development of the enamel portion of the tooth.

In the canines and incisors the process of development is the same as in the more posterior teeth, except that there is but a single cusp or edge. The occasional secondary additional cusp, when to be formed, develops subsequently from the heel or tuberosity, which in these teeth seems to be the only "potential" part of the cingulum.

According to these observations, which in the course of time will doubtless receive more precision, the cingulum is a regular and inseparable part of the epithelial or enamel development of each tooth. It is something not superadded, but inherent in the crown. It exists for special purposes. What these purposes are, is plain enough: They

are in the first place to strengthen the crown; and in the second to provide in response to functional call for the possibility of additional cusping and hence for an increase in the effectiveness of a tooth.

In the incisors the cingulum develops the lingual heel; from this heel it sends out to the crown one or two strengthening ridges; the point of the heel differentiates occasionally into one or more points, a cuspule, or even a definite cusp which may reach as far as the cutting edge of the crown and convert the tooth into a bicuspid. In the canines is formed a lingual heel, which often gives rise to a cuspule. In the premolars, the original lingual cingulum cusp has already become a fixed feature; but occasionally—in the gorilla, other anthropoid apes and even man—the remaining cingulum of the premolars begins mesially (posteriorly) to respond to functional need with a third, and even a fourth cusp (anthropoids). The molars, too, have apparently but one protocusp, with two to three already fixed cingulum cusps, and a remaining cingulum capable of producing still other cusps or tubercles.

In view of the preceding, the cingulum may perhaps be defined as the basal, inherent, inseparable, but histogenetically the most potential, part of each tooth crown.

THE CROWN "SUTURE"

Examination under a magnifying glass of a large number of immature, permanent Indian teeth, incisors, canines, premolars and molars, showed in over half of the cases that the crown of the tooth was crossed labially, and sometimes all around, by a peculiar serrated or interdigitate line which could not be identified with anything hitherto described in the dental literature that was at the writer's disposal, and which under low magnifying power resembled not a little some forms of sutures.

As already mentioned, the first few examples of this "suture" were in such a situation as to suggest that they might indicate a possible superior limit of the cingulum, which if that were true would have to be regarded as an accessory part of each tooth. Subsequently however the "suture" was found in crowns that have reached nowhere near the usual location of the cingulum, and it was recognized that we were confronted here with quite a different manifestation.

Just what this feature is, is as yet not clear. It is something quite different from the so-called "Schreger's" lines. It is not only present

on all forms of teeth, but occasionally shows even a better development on the canines, premolars and molars than on the incisors. Near one-half of the immature Indian teeth show no trace of it. The crowns that do show it, so far as observed, are from about one-third to nearly fully developed, and as far as can be seen fully normal.

As to location, the "suture" runs in most cases 1 to 3 mm. above the lower border of the crown; but it runs higher than this not infrequently. In one about half or a little more developed upper median incisor crown, it runs across the middle and slightly above the middle of the part already developed; while in another about two-thirds developed crown of a lateral upper incisor, it runs even higher, namely from near the cutting edge on the left to a point between the distal and middle thirds of the part that has already been formed on the right side of the labial surface of the crown. In the premolars and molars, the "suture" may run partly over the less important cusps.

FIGURE 2. Crown "Suture" in various immature American Indian teeth. (U. S. National Museum.)

a. Lateral incisor, crown about ¾ developed, showing a very high location of the "suture."

b. Half developed crown of an upper median incisor, with "suture" in about the middle.

c. A fully (or nearly fully) developed crown of an upper median incisor with "suture" low down.

d. Crown of a canine, about ⅔ (or a little over) developed with a relatively simple "suture."

e. Crown of an upper premolar, about ⅔ developed, "suture" rather high, oblique.

Under low magnifying power the "suture" appears consisting of a belt-like complex of numerous angular more or less vertical lines which here and there connect, the connecting lines being partly curved and partly straight. Under stronger enlargement it is seen that the lines are so many crevices in the enamel, which separate deeply but often more or less incompletely numerous irregular enamel blocks. The "suture" is therefore, properly, a more or less broad and complex ring of defects of cementation.

Just what all this represents must be left to future determination. The crown "sutures," though probably accentuated somewhat by the

dryness of old specimens, are plainly no mere lines of accidental cracks nor any other artifacts. They do not extend to the dentine, but involve the enamel only. They may "furrow" a whole cusp. They bear no sign of being connected with anything pathological. They progress from the distal towards the proximal parts of the crown, as the crown grows. Their remnants in fully developed crowns may possibly be the "Schreger's lines." They evidently have some definite and perhaps regular connection with the development of the enamel surface of the crown, and could possibly be conceived as more or less circular areas or lines of demarcation between the older fully differentiated and the younger parts of the crown, or as areas or lines of secondary cementation in the enamel; but for the present no valid opinion can be given.

The same feature but in somewhat modified forms was since seen in the Division of Mammals of the U. S. National Museum, in an immature molar of a leopard, in a very young crown of a molar of a chimpanzee (No. 176,233), and in the immature upper incisors and premolars of a baboon (162,845).

ADDITIONAL OBSERVATIONS ON HUMAN INCISORS

LINGUAL CUSPS

PLATES III, V

A lingual cusp may be defined as a more or less marked, single, double or multiple protuberance from the heel of an incisor or a canine. The lingual heel is, as shown before, the essential part of the cingulum of these teeth.

In mature human teeth the heel and the lingual cusps are variously represented. The heel may be seemingly absent, inconspicuous, or replaced by an extension or fusion of the marginal crests; or it may rise to a moderate convexity or be developed into a strong tuberosity. It may often be seen to be separated on one or even both sides from the lateral border or borders of the tooth by a shallow to marked groove, and in the lateral upper incisor the portion of the root which supports the heel may show a vertical furrow, indicating a prospective separation into two roots. From the heel may rise one or two more or less elevated ridges which are prolonged to and taper out on the lingual surface of the tooth; or instead of ridges there project from the heel one, two or even more buds or points, the lingual accessory

cuspules. A single strong lingual cusp may in extreme cases, in an incisor, reach near or to the cutting edge of the tooth and give the same a form approaching that of a bicuspid.

The lingual cusps occur most frequently and as a rule singly on the canines; singly and less frequently, rarely doubly, on the lateral upper incisors; singly and very rarely on the lower incisors; and doubly, singly, or in several points on the upper median incisors. They are found in teeth that are shovel-shaped as well as in teeth that are flat, and they seem to occur in all living races of man, but in a human-like form have not as yet been signalled in any of the primates or lower mammals, though the heel or tuberosity in many of these is well developed and may show an edge-like excrescence.

These accessory cusps have long been known in dental literature, but their exact frequency and racial distribution have never been determined. Such determinations moreover are not easy, the difficulty lying in what to and what not to include under the term "cusp," particularly in the case of the median incisors. As a result, probably no two observers would reach precisely the same results on the same series of specimens; but the differences would in all probability not be serious enough to obscure the main facts.

The writer has used the same material in the study of these cusps as that in the study of the shovel-shaped formation, with the results shown in the table below. Only those features were included as "cusps" which could be readily discerned as such. As the results indicate, such cusps are present in approximately 5 per cent of all the cases, with a slight excess showing in the males over the females, and in the colored (particularly females) over the whites. In a large majority of the cases the cusp was single, but in a certain proportion of individuals, particularly among the colored, the median and even the lateral incisors showed two small cusps. More than two cusps were not observed in any case of any group. The double cusp was generally more of the nature of a marked double elevation, rising from the heel and gradually losing itself on the lingual surface of the teeth. But no simple ridges, though homologous, were included in this category, and in some of the cases the cusps were more or less free from the enamel behind. In rare instances the secondary cusp, while not free, reached to near the cutting edge of the incisor, forming a tooth resembling more or less a bicuspid.

The writer's impression is that these cusps are functional acces-

sories; and that they are not more frequent among the yellow-brown peoples than among the whites; but both points deserve further investigation. Data on Indian teeth appended to the table, indicate conditions but little different from those in the whites and American negroes.

CUSPS IN DECIDUOUS HUMAN TEETH

The skeletal material of Indian children in the U. S. National Museum enabled the writer to examine 41 deciduous upper median and 39 deciduous upper lateral incisors in good condition. Of these, two medians (near 5 per cent) and two laterals (slightly over 5 per cent) showed a distinct small basal cusp. In addition twelve of the medians and ten of the laterals presented a "swollen" heel or tuberosity, a condition seemingly on the verge of a cusp formation.

LINGUAL CUSPS.

	On all Permanent Incisors		Both Medians		Both Laterals		Right Lateral Only		Left Lateral Only		Anomalous	Teeth with Cusps	
	1 cusp.	2 cus.	1 cusp.	2 cus.	1 cusp.	2 cus.	1 cusp.	2 cus.	1 cusp.	2 cus.		No.	Pct.
WHITE MALES (500)	Individuals: 6 Pct. of 1.2	2 Indiv. 0.4	5 1.0	5 1.0	25 5.0	....	6 1.2	....	3 0.6	....	....	111 (of 2000 inc's)	5.6
WHITE FEMALES (500)	2 0.4	....	1 0.2	4 0.8	28 5.6	....	3 0.6	....	2 0.4	3 0.6	....	81	4.05
COLORED MALES (307)	4 1.3	2 0.6	1 0.3	4 1.3	12 3.9	....	6 2.0	....	2 0.6	3 1.0	3 1.0	72 (of 1228 teeth)	5.8
COLORED FEMALES (500)	....	5 1.0	5 1.0	4 1.8	28 5.6	1 0.2	5 1.0	....	4 0.8	....	.... 0.2	106	5.3
AMERICAN INDIANS 302 medians 353 laterals	Teeth Per cent		Medians, r. or l. 5 1.6	5 1.6	Laterals, r. or l. 27 7.6							37	5.6

DEGENERATE AND ABSENT INCISORS

The lateral incisor, as well known, presents not infrequently a more or less degenerate form with reduction in size. It may be represented by a mere peg, and may be absent altogether. Records of these conditions were taken in all the groups examined by the writer, and the results, summarized in the accompanying tables, are rather interesting.

No case was seen of a degenerate median incisor, and in only one instance was one of these teeth congenitally absent—possibly impacted.

UPPER INCISORS DEGENERATE

	MALES					FEMALES				
Living Subjects	Both Laterals Involved	Right Lateral	Left Lateral	Total		Both Laterals	Right Lateral	Left Lateral	Total
WHITES (500)	Individuals (10) Percent: 2.0	(4) 0.8	(3) 0.6	(17) 3.4	WHITES (500)	(6) 1.2	(3) 0.6	(5) 1.0	(14) 2.8
AMERICAN NEGRO (307)	(6) 2.0	(1) 0.3	(1) 0.3	(8) 2.6	AMERICAN NEGRO (500)	(14) 2.8	(6) 1.2	(2) 0.4	(22) 4.4
HAWAIIAN (21)	(1) 5.0	... ...	... ...	(1) 5.0	HAWAIIAN (38)	... ...	... ...	... ...	... ..
CHINESE (547)	(31) 5.7	(5) 0.9	(10) 1.8	(46) 8.4	CHINESE (104)	(2) 2.-	... ...	(2) 2.-	(4) 4.-
JAPANESE (172)	(5) 2.9	(2) 1.2	(1) 0.6	(8) 4.7					

CONGENITAL ABSENCE OF LATERAL UPPER INCISORS

	MALES					FEMALES					
Living Subjects	Medians	Both Laterals Absent	Right Lateral	Left Lateral	Totals		Medians	Both Laterals	Right Lateral	Left Lateral	Totals
	Individuals:										
WHITES (500)	1(r.m.) Pct. 0.2	(3) 0.6	(1) 0.2	(2) 0.4	(7) 1.4	WHITES (500)	... ...	(6) 1.2	(5) 1.0	(4) 0.8	(15) 3.0
AMERICAN NEGRO (307)	... ...	2 0.6	2 0.6	1 0.3	(5) 1.6	AMERICAN NEGRO (500)	... ...	(3) 0.6	(4) 0.8	(2) 0.4	(9) 1.8
HAWAIIAN (21)	... ...	... ...	... ...	... ...	... ...	HAWAIIAN (38)	... ...	(1) 2.6	... ...	... ...	(1) 2.6
CHINESE (547)	... ...	... ...	... ...	(1) 0.2	(1) 0.2	CHINESE (104)	... ...	... ...	... ...	... ...	... ...
JAPANESE (172)	... ...	1 0.6	1 0.6	... ...	(2) 1.2						

The total number of individuals showing degenerate upper lateral incisors amounted, among the American Whites, to a little over 3 per cent of the males, and a little below 3 per cent in the females. In the Negro, the proportion was below 3 per cent in the males to above 4 per cent in the females, but the females included more of the "lighter colored" in whom the condition appears to be more frequent than in the "darker" subjects and full-bloods. In the Chinese, the proportion of degenerate upper lateral incisors is more than twice as frequent as

in the Whites in the males, and also perceptibly more frequent in the females; and there is also a higher proportion of the condition present in the Japanese.

As to congenitally absent upper lateral incisors, a condition the reverse of that found with the degenerate teeth is observable (except in the Chinese group)—they are more common in the females than in the males. Also their absence is slightly more common in the American Whites than in the Negroes, and somewhat more common in both of these than in the Chinese and Japanese. It is evident therefore that the statistical study of both degenerate and congenitally absent lateral incisors in the different races deserves further investigation.

Both the degenerate condition and the absence of the lateral incisors have been noted by many Odontologists; but the data for various reasons are not readily comparable. About the best series has been reported by Röse.[1] Among 12,250 living northern and central Europeans (soldiers and recruits in Germany and Sweden), degenerate or absent lateral incisors, taken together, were noted in 3.2% of the men; while in 2811 crania (of, in the main, colored races), the proportion of degenerate or absent lateral upper incisors was but 1.1%. Röse's conclusions with which in the main it is possible to agree, were that:

"The degeneration of the upper lateral incisors and that of the wisdom teeth rests on phylogenetic causes and not on unfavorable accommodation in pathologically changed maxillae.

In the higher standing European races with larger brains the degeneration of the lateral upper incisors and that of the wisdom teeth is in general farther advanced than in non-European races.

In the nordic longheads the lateral upper incisors are more often, the wisdom teeth less often reduced than among the shortheads of the Alpine race.

In the females, degeneration of the upper lateral incisors is further advanced than in males."

The subject will well repay a further study on large series of both living and skeletal material.

[1]Röse (C.). Uber die Rückbildung der seitlichen Schneidezähne im menschlichen Gebisse. D. Monatsschr. f. Zahnheilk., 1906, XXIV, 5.